

January 2, 2002

*CURRICULUM VITAE*

**CHARLES L. COONEY**

**Present Position**

Professor of Chemical and Biochemical  
Engineering  
Department of Chemical Engineering  
Massachusetts Institute of Technology

Co-Director, Program on the  
Pharmaceutical Industry  
Massachusetts Institute of Technology

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**Education**

Massachusetts Institute of Technology  
Cambridge, MA

S.M. Biochemical Engineering (1967)  
Ph.D. Biochemical Engineering (1970)

University of Pennsylvania  
Philadelphia, PA

B.S. Chemical Engineering (1966)

**Honors**

Founding Fellow, American Institute for Medical and Biological Engineering, 1992  
Institute of Biotechnological Studies, 1989 Gold Medal  
James Van Lannen Award for Distinguished Service to the Division of Microbial and  
Biochemical Technology of the American Chemical Society, 1985  
Food, Pharmaceutical and Bioengineering Division Award, American Institute of

Chemical Engineers, 1983.  
Becten-Dickenson Award lecturer, American Society for Microbiology, 1977  
Listed in Who's Who in Frontiers of Science and Technology  
Listed in American Men of Science  
Sigma Xi

### Major Research Interests

Biochemical Process Engineering and Synthesis  
Computer Monitoring & Control of Fermentation and Recovery Processes  
Isolation and Purification of Biological Products  
Production, Immobilization and Application of Enzymes  
Manufacturing Strategies in the Pharmaceutical Industry

### Research and Professional Experience

1995-2001	Executive officer, Department of Chemical Engineering, M.I.T.
1996-Jan to June	Acting Department Head, Department of Chemical Engineering, M.I.T.
1982-present	Professor of Chemical and Biochemical Engineering, M.I.T.
1975-1982	Associate Professor of Biochemical Engineering,
1970-1975	Assistant Professor of Biochemical Engineering,
1970 (summer)	Consultant in Fermentation Technology, The Squibb Institute for Medical Research
1970	Instructor of Biochemical Engineering, M.I.T.
1966-1970	NIH Trainee, M.I.T.
1966	Chemical Engineer, E.I. DuPont de Nemours & Co.

### Primary Teaching Responsibility

Biochemical Engineering (10.542, with \_\_\_\_\_ taught since 1970)  
Bioseparation Processes (10.565, taught semi-annually since 1982)  
Principles and Practice of Drug Development (10.547J, taught annually since 1991)  
Biochemical Engineering Laboratory (10.591, taught annually from 1970 to 1985 with \_\_\_\_\_)  
Chemical Kinetics and Reactor Design (10.37, annually from 1990-1998)  
Downstream Processing in Biotechnology (Course Director, Summer course taught annually since 1985)  
Fermentation Technology (Summer course taught annually since 1970)  
Management Skills for Physicians, Scientists and Engineers in the Pharmaceutical Industry (Summer course taught annually 1991-1997)

## Visiting Professorships

2001-2002, Visiting Professor, Department of Chemical Engineering, University of Cambridge, Cambridge, UK  
1975, June Oeiras, Portugal, Lectures and Laboratory in Continuous Microbial Culture  
1974, November, Visiting Professor of Biochemical Engineering, Department of Chemical Engineering University of Waterloo, Canada  
1974, August, Visiting Professor, Centro de Investigacion del IPN, Mexico City, Mexico  
1973, March, Visiting Professor, Gulbenkian Institute,

## Membership in Professional Societies

American Association for the Advancement of Science (AAAS)  
American Chemical Society and the Division of Microbial and Biochemical Technology (ACS)  
American Institute of Chemical Engineers and the Food, Pharmaceutical and Bioengineering Division (AIChE)  
American Society for Microbiology and the Fermentation and Biotechnology Division (ASM)  
International Society for Pharmaceutical Engineering (ISPE)  
Society for Industrial Microbiology (SIM)

## Research Proposal and Paper Review

Regional Editor for Bioseparations, 1989 to present  
Editorial Board of Journal of Fermentation and Bioengineering, 1990 to present  
Editor of Biotechnology Advances, 1982 to 1992  
Editorial Board for Applied Biochemistry and Biotechnology, 1980 to present  
Editorial Board for Advances in Biochemical Engineering, 1982 to present  
Editorial board for Trends in Biotechnology, 1983 to 1997  
Editorial Board for Journal of Biotechnology, 1983 to present  
Editorial Board for Thai Journal of Biotechnology, 1998 to present  
Editorial Advisory Board for the Second Edition of a series:  
Biotechnology, Verlag Chemie, 1990-1994  
Editorial Board for Biotechnology Letters, 1980 to 1990  
Editorial Board for Biotechnology Techniques, 1987 to 1990  
Editorial Board of Applied and Environmental Microbiology, 1973 to 1980  
Editorial Board for Journal of Applied Chemistry and Biotechnology, 1978 to 1982  
Advisory Board for the CRC Handbook of Bio-Solar Resources, 1977 to 1983  
Editorial Board for Advances in Biotechnology, 1979 to 1980  
Editorial Board of MIRCEN Journal of Applied Microbiology and Biotechnology, 1986-1990  
Proposal Review for:  
National Science Foundation

National Institutes of Health  
Department of Energy  
Canadian National Science and Engineering Research Council

### **Offices and Committees in Professional Societies**

Division of Microbial and Biochemical Technology of the American Chemical Society: Secretary/Treasurer, 1974 to 1978; Chairman-Elect and Program Committee, 1978; Chairman, 1979; Executive Committee, 1974 to 1980; Newsletter Editor, 1980 to 1982  
Fermentation and Biotechnology Division, American Society for Microbiology: Chairman-Elect, 1983; Chairman, 1984  
Continuing Education Committee of American Institute of Chemical Engineers, 1986 to 1994  
Committee on International Affairs, American Society for Microbiology, 1980 to 1983  
Liaison committee between the Division of Microbial and Biochemical Technology (ACS), and the League for International Food Education (LIFE), Chairman 1973 to 1974  
Standards Committee, Food and Bioengineering Section of the American Institute of Chemical Engineers (AIChE), 1971 to 1974

### **Major Scientific Conference Organization**

Recovery of Fermentation Products, Engineering Foundation Conference, Sea Island, Georgia, Co-chairman  
Recovery of Bioproducts, Engineering Foundation Conference, Uppsala, Sweden, May 11-16, 1986, Co-chairman  
Recovery of Biological Products IX, Whistler, BC, May 1999 Co-Chairman

### **U.S. and International Organizations**

Board – Recovery of Biological Conference Series, 1998-present  
Biotechnology Panel of the Canadian National Science and Engineering Research Council (NSERC) for review of Strategic Grants, 1983 to 1986  
Biotechnology Commission of the International Union of Pure and Applied Biochemistry (IUPAC), Titular Member, 1977 to 1981; Vice-Chairman, 1979 to 1981; Chairman, 1982 to 1985  
UNEP/UNESCO/ICRO Biotechnology and Applied Microbial Genetics Committee, 1977 to 1990  
International Committee for Economic and Applied Microbiology (ICEAM), Member-at-Large, 1974 to 1978; Vice-Chairman, 1978 to 1982; Executive Committee, 1982-1984  
Joint Working Group on the Production of Substances by Microbial Fermentation and Microbial Processes, 1979 to 1983; Control of Fermentation, 1974 to 1970; Project Coordinator on Cooperation. Advisor in the area of Modelling and Computer Means.

US-USSR Joint Commission on Scientific and Technical Research and Development Panel of the Department of Energy, Energy Research Advisory Board (ERAB), 1980 to 1982  
Biomass Panel of the Department of Energy, Energy Research Advisory Board (ERAB), 1980 to 1982

Ad Hoc Gasohol Study Group for Department of Energy, Energy Research Advisory Board (ERAB), 1979 to 1980

Subcommittee of Committee on Animal Nutrition (CAN), National Research Council on Feeding Underutilized Feedstuffs to Animals, 1978 to 1983

New Technology and Industrial Biotechnology Panel, Committee on Research Opportunities in Biology, Commission on Life Sciences, National Research Council, 1987-1989

Committee on Bioprocess Engineering, Commission on Life Sciences, National Research Council, 1991-1992

### **M.I.T. Committees**

MIT Industry Council on Industrial Relations (1996-1998)

Administrative Clustering Committee, Department of Chemical Engineering (1996)

Department Computer Committee (1995-present)

Ad hoc Committee on Departmental Operations (1993-94)

MIT Professional Institute Steering Committee, MIT (1993-present)

Institute Committee on Corporate Relations 1993-1996, Chairman, 1996

Ad Hoc Committee on Chemistry in Chemical Engineering (CINCHE) 1991

Graduate Admissions Committee, Department of Chemical Engineering, 1990-1995

Undergraduate Committee, Department of Chemical Engineering, 1989 to present, Chairman, 1995-2001

Community Service Fund Board, MIT Institute Committee, 1986 to present

Biotechnology Process Engineering Center (BPEC) Operating Committee, 1985 to 1994

Interdepartmental Biotechnology Committee, Co-Chairman, 1983 to 1985

Chemical Engineering Practice School Steering Committee, 1983 to 1989

Faculty Search Committee, Department of Chemical Engineering, M.I.T. 1981 to 1987 and 1995 to present

Faculty Search Committee, Department of Applied Biological Sciences, M.I.T. , 1983 to 1984

Independent Activities Period Committee, M.I.T. Institute Committee, 1981 to 1984

Ad Hoc Committee on Faculty and Staff Retirement Income and Related Benefits, M.I.T. Institute Committee, 1978 to 1980

Staff-Administration Committee, M.I.T. Institute Committee, 1976 to 1979

Committee on Graduate Students, Nutrition and Food Science Department Committee, 1979-1982

Committee on Nutrition and Food Science Departmental Resources, Chairman, 1979-1981

Undergraduate Affairs Committee, Nutrition and Food Science Department Committee, 1973 to 1982; Chairman, 1977 to 1982

Undergraduate Research Opportunities Program, Nutrition and Food Science Department Coordinator, 1971 to 1974; 1978 to 1981

Committee on U.S. Competitiveness, 1987-1989

### **International Review Panels**

External Review Committee, Department of Chemical Engineering, University of Cambridge, 2000-present

VIB International Review Panel, Chairman, 1999

External Review, Department of Food Engineering and Biotechnology, Technion, Israel, 2001

**APPEARS THIS WAY  
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## Personal Publications

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### A. Control of Cell Physiology in Continuous Culture

1. Humphrey, A.E., A. Kitai and C.L. Cooney. (1966). Dynamics of bacterial spore cultivation in batch and continuous culture. J. Ferm. Tech. **44**, 181-200.
2. Cooney, C.L. and R.I. Mateles. (1971). Fermentation kinetics, in Recent Advances in Microbiology, A. Perez-Miravete and D. Pelaez, eds., Asociacion Mexicana de Microbiologie, pp. 441-449.
3. Demain, A.L. and C.L. Cooney. (1972). Continuous culture-1971. Proc. Biochem. **1**(7), 21-23.
4. Acevedo, F. and C.L. Cooney. (1975). Penicillin amidase production by *Bacillus megaterium*. Biotech. Bioeng. **15**, 493-503.
5. Acevedo, F. and C.L. Cooney. (1975). Penicillin amidase and penicillinase production in nitrogen and sulfur limited chemostats. Eur. Jour. Appl. Microbiol. **2**, 9-17.
6. Cooney, C.L., H.M. Koplove, and F. Acevedo. (1975). Production of enzymes in continuous culture. Proceedings of US/USSR Symposium.
7. Cooney, C.L., D.I.C. Wang and R.I. Mateles. (1976). Growth of *Enterobacter aerogenes* in a chemostat with double nutrient limitation in chemostat. Biotech. Bioeng. **18**, 189-198.

8. Cooney, C.L. and D.I.C. Wang. (1976). Transient response of *Aerobacter aerogenes* under dual nutrient limitation in chemostat. Biotech. Bioeng. 18, 189-198.
9. Acevedo, F. and C.L. Cooney. (1976). Production of extra-cellular enzymes in continuous culture. Eur. J. Appl. Microbiol. 2, 9-13.
10. Matteo, C.C., C.L. Cooney and A.L. Demain. (1976). Production of gramicidin S synthetases by *Bacillus brevis* in continuous cultures. J. Gen. Microbiol. 96, 415-422.
11. Koplove, H.M. and C.L. Cooney. (1978). Acetate kinase production by *Escherichia coli* during steady state and transient growth in continuous culture. J. Bacteriol. 134, 992-1001.
12. Koplove, H.M. and C.L. Cooney. (1979). Production of enzymes during transients in continuous culture. Adv. Biochemical Engr. 12, 1-40.
13. Cooney, C.L. (1979). Continuous culture of microorganisms: an overview and perspective. Ann. N.Y. Acad. Sci. 236, 295-314.
14. Cooney, C.L., H.M. Koplove and M. Haggstrom. (1981). Transient phenomena in continuous culture, in Continuous Culture of Cells, Vol. I, P.H. Calcott, ed., CRC Uniscience Series, pp. 143-158.
15. Swartz, J.R. and C.L. Cooney. (1981). Methanol inhibition in continuous culture of *Hansenula polymorpha*. Appl. Env. Microbiol. 41, 1206-1213.
16. Schaefer, E.J. and C.L. Cooney. (1982). The production of maltase by *Saccharomyces italicus*. Appl. Env. Microbiol. 43, 75-80.
17. Haggstrom, M.H. and C.L. Cooney. (1985).  $\alpha$ -glucosidase synthesis in batch and continuous culture of *Saccharomyces cerevisiae*. Appl. Biochem. Biotechnol. 9, 475-81.
18. Cooney, C.L. (1985). Continuous culture: A tool for research development and production. Proceedings of First Arabian Gulf Conference on Biotech. and Appl. Microbiol.
19. Piret, J. M. and C. L. Cooney. (1991). Mammalian Cell and Protein Distributions in Ultrafiltration Hollow Fiber Reactors. Biotech. and Bioeng. 36, 902-910.
20. Piret, J. M. and C. L. Cooney. (1991). Model of Oxygen Transport Limitations in Hollow Fiber Bioreactors. Biotech. and Bioeng. 37, 80-92.
21. Piret, J. M. , D. A. Devens and C. L. Cooney. (1991). Nutrient and Metabolite Gradients in Mammalian Cell Hollow Fiber Bioreactors. Can. J. Chem Eng. 69, 421-428.
22. Piret, J. M. and C. L. Cooney. (1991). Hybridoma, Antibody and Growth Factor Distribution in the Shell-Side of Ultrafiltration Hollow Fiber Bioreactors. Proc. European Soc. Animal Cell Tech. (in Press).



23. Piret, J. M. and C. L. Cooney. (1991). Immobilized Mammalian Cell Cultivation in Hollow Fiber Bioreactors. Biotech. Adv., 8: 763-783.

24. Laska, M. and C. L. Cooney. (1999). Bioreactors, Continuous Stirred-Tank Reactors. *Encyclopedia of Bioprocess Technology*. John Wiley & Sons, New York 353-371

## **B. Biochemical Engineering of Renewable Resource Utilization for Fuels and Chemicals Production**

1. Cooney, C.L. and D.L. Wise. (1975). Thermophilic anaerobic digestion of solid waste for fuel gas production. Biotech. Bioeng. 17, 1119-1135.

2. Cooney, C.L. and R. Ackerman. (1975). Thermophilic anaerobic digestion of cellulosic waste. Eur. J. Appl. Microbiol. 2, 65-72.

3. Augenstein, D.C., D.L. Wise, R.L. Wentworth and C.L. Cooney. (1976). Fuel gas recovery from controlled land filling of municipal wastes. Resource Recovery and Conservation 2, 103-107.

4. Troiano, R.D., D.L. Wise, D.C. Augenstein, R.G. Kispert and C.L. Cooney. (1976). Fuel gas production by anaerobic digestion of kelp. Resource Recovery and Conservation 2, 171-176.

5. Augenstein, D.C., D.L. Wise and C.L. Cooney. (1977). Packed bed digestion of solid wastes. Resource Recovery and Conservation 2, 257-262.

6. Wise, D.L., C.L. Cooney and D.C. Augenstein. (1978). Biomethanation: anaerobic fermentation of CO, H<sub>2</sub>, and CO<sub>2</sub> to methane. Biotech. Bioeng. 20, 2253-1172.

7. Wise, D.L., R.L. Wentworth, D.C. Augenstein and C.L. Cooney. (1977). Multistage digestion to fuel gas of municipal solid waste. Pac. Chem. Eng. Congr. (Proceedings) 2, 769-776.

8. Wise, D.L., R.L. Wentworth, D.C. Augenstein and C.L. Cooney. (1978). Multistage digestion of municipal solid waste to fuel gas. Resource Recovery and Conservation 3, 41-59.

9. Gordon, J., M. Jiminez, C.L. Cooney and D.I.C. Wang. (1978). Sugar accumulation during fermentation of cellulose. Am. Inst. Shem. Eng. Simp. Series 74, 91-97.

10. Cooney, C.L., D.I.C. Wang, S.D. Wang and J. Gordon. (1979). Simultaneous cellulose hydrolysis and ethanol production by a cellulolytic, anaerobic, bacterium. Biotech. Bioeng. Symp. Series 8, 103-114.

11. Wang, D.I.C., C.L. Cooney, S.D. Wang, J. Gordon, and G.Y. Wang. (1978). Anaerobic biomass degradation to produce sugars, fuels and chemicals. Proceedings of 2nd Annual Symposium on Fuels from Biomass, R.P.I.
12. Cooney, C.L., and I. Goldberg. (1978). Biocatalysis as a route to chemical manufacture from syngas. 87th National Meeting of AIChE.
13. Wang, D.I.C., C.L. Cooney, J. Gordon, and G.Y. Wang. (1978). Anaerobic biomass degradation to produce sugars, fuels, and chemicals. Proceedings of the 2nd Annual Symposium of Fuels from Biomass.
14. Cooney, C.L., R. Yates, F. Vera-Solis, and M. Jiminez. (1979). The production of lactic acid from cellulose by defined mixed cultures of thermophiles...not found.....
15. Winter, J.U. and C.L. Cooney. (1980). Fermentation of cellulose and fatty acids with enrichment cultures from sewage sludge. Eur. J. Appl. Microbiol. **11**, 60-66.
16. Dalal, R., M. Akedo, C.L. Cooney and A.J. Sinskey. (1980). A microbial route to acrylic acid production. Bioresources Digest **2**(2), 89-97.
17. Gold, D., I. Goldberg and C.L. Cooney. (1980). Biological production of chemical feedstocks for synthesis gas. ACS Division of Petroleum Chemistry Preprints **25**(3), 575-582.
18. Gordon, J. and C.L. Cooney. (1981). Fermentation production of sugar from cellulose by *Clostridium thermocellum*. Advances in Biotechnology, Vol. I, M. Moo-Young, ed., Pergamon Press, New York, pp. 15-20.
19. Gomez, R.F., G.C. Avgerinos, C.L. Cooney, and D.I.C. Wang. Direct Conversion of cellulosic biomass to ethanol by microbial fermentations. Proceedings of Symposium of Sugar and Ethanol Producers of Brazil.
20. Goldberg, I. and C.L. Cooney. (1981). Formation of short-chain fatty acids from H and CO by a mixed culture of organisms. Appl. Env. Microbiol. **41**, 148-154.
21. Sinskey, A.J., M. Akedo and C.L. Cooney. (1981). Acrylate fermentations. Trends in the Biology of Fermentations, A. Hollaender, ed., Plenum Press, New York, pp. 473-492.
22. Cooney, C.L. (1981). The utilization of cellulosic biomass for production of liquid fuels. Testimony Hearings of Subcommittee on Energy Development and Applications.
23. Cooney, C.L. (1981). Fuels and chemicals production using lignocellulosic materials. Le Journees de la Biotechnologie, L'Ecole de Mines, Paris.
24. Schmidt, Robert L. and C.L. Cooney. (1985). Production of Acetic Acid from Hydrogen and Carbon Dioxide by *Clostridium* Species ATCC 29797. Chemical Engineering Communications, William N. Gill, ed., Gordon and Breach, New York, pp. 61-73.

25. Cameron, D C., and C.L.Cooney. (1986). A novel fermentation: The production of R(-) - 1,2-propanediol and acetol by *Clostridium thermosaccharolyticum*. Bio/Technology. 4, 651-654.
26. Simon, Ethan S., Whitesides, G.M., Cameron, D.C., Weitz, D. J. and Cooney, C. L. (1987). A combined microbial/chemical synthesis of (+)-(R)-Methyloxirane having high enantiomeric excess. The Journal of Organic Chemistry. 52, 4042.
27. Sanchez-Riera, F., Cameron, D.C., and Cooney, C.L. (1987). Influence of environmental factors in the production of R(-)-1,2 propanediol by *Clostridium thermosaccharolyticum*. Biotechnology Letters. 9(7), 449-454.
28. Mistry, F. R., and Cooney, C. L. (1989). Production of Ethanol by *Clostridium thermosaccharolyticum*: I. A quantitative model describing product distributions. Biotech. Bioengr. 34, 1296-1304.
29. Mistry, F.R. and Cooney, C. L. (1989). Production of Ethanol by *Clostridium thermosaccharolyticum*: II. Effect of cell recycle and environmental parameters. Biotech. Bioengr. 34, 1304-1315.

### C. Single-Cell Protein

1. Tannenbaum, S.R. and C.L. Cooney. (1969). Influence of conditions of culture on variability of protein content and amino acid pattern of single-cell protein, Proceedings of the Eighth International Congress of Nutrition, Prague.
2. Cooney, C.L. and D.W. Levine. (1972). Microbial utilization of methanol. Adv. Appl. Microbiol. 15, 337-365.
3. Levine, D.W. and C.L. Cooney. (1973). Methanol utilization by a thermotolerant strain of *Hansenula polymorpha*. Appl. Microbiol. 26, 982-990.
4. Snedecor, B. ad C.L. Cooney. (1974). A thermophilic mixed culture of bacteria utilizing methanol for growth. Appl. Microbiol. 27, 1112-1117.
5. Cooney, C.L., D.W. Levine and B. Snedecor. (1974). Single-cell protein production from methanol. Food Tech. 29(2), 33-42.
6. Cooney, C.L. (1975). Engineering considerations in the production of single-cell protein from methanol. Microbial Growth on C-Compounds, Soc. of Fermentation Technology, Japan, pp. 183-197.
7. Cooney, C.L. and D.W. Levine. (1975). Yeast production from methanol as a source of single-cell protein. Single-Cell Protein II, MIT Press, Cambridge, Ma, pp. 402-423.

8. Cooney, C.L. and S.R. Tannenbaum. (1975). Variation of composition of bacteria and yeast and its significance to single-cell protein production. International Biological Programme Synthesis Volume on Protein Resources, N.W. Pirie, ed., Cambridge University Press, pp. 223-230.
9. Cooney, C.L. (1976). Food from chemicals. Environmental Chemistry, T. Bockris, ed., Plenum Press, NY, pp. 53-94.
10. Cooney, C.L. and N. Makiguchi. (1979). Temperature as an engineering parameter in single-cell protein production. Proceedings of V International Symposium on Continuous Culture, Plenum Press, pp. 146-157.
11. Cooney, C.L., and N. Makiguchi. (1977). An assesment of single-cell protein from methanol grown yeast. Biotech. Bioeng. Symp. Ser. 7, 65-76.
12. Cooney, C.L. and D.I.C. Wang. (1977). Engineering problems in hydrocarbon fermentations. Proceedings of the IV Global Impacts of Applied Microbiology, Sociedade Brasileira de Microbiologia, J.S. Furtado, ed., pp. 873-898.
13. Cooney, C.L., B.R. Snedecor, D.W. Levine, R.A. Ackerman and J. Lee. (1977). Thermophilic processes for the production and utilization of C-1 compounds. Developments in Industrial Microbiology 18, 255-266.
14. Cooney, C.L., C.K. Rha and S.R. Tannenbaum. (1981). Single-cell protein: Engineering, economics and utilization in foods. Adv. Food Res. 26, 1-47.

#### **D. Computer-Aided Fermentation and Instrumentation**

1. Cooney, C.L., D.I.C. Wang and R.I. Mateles. (1968). Measurement of heat evolution and correlation with oxygen consumption during microbial growth. Biotech. Bioeng. 11, 269-281.
2. Cooney, C.L., and D.I.C. Wang. (1971). Oxygen transfer and control. Biotech. Bioeng. Symp. No. 2, 63-75.
3. Cooney, C.L., H. Wang and D.I.C. Wang. (1971). Computer aided fermentation monitoring and diagnostics. US/USSR Joint Symposium. Univ. of Penn, PA.
4. Koplove, H.M. and C.L. Cooney. (1976). A continuous assay for an intracellular enzyme: the analysis of acetate kinase in E. coli. Anal. Biochem. 72, 297-304.
5. Mou, D.G. and C.L. Cooney. (1976). Application of dynamic calorimetry for monitoring fermentation processes. Biotech. Bioeng. 18, 1371-1392.
6. Swartz, J.R., H. Wang, C.L. Cooney and D.I.C. Wang. (1976). Computer aided yeast fermentation. Presented at 5th International Fermentation Symposium. Berlin.

7. Cooney, C.L. and F. Acevedo. (1977). Theoretical conversion of glucose, ammonia, and sulphate to Penicillin G. Biotech. Bioeng. 19, 1449-1462.
8. Cooney, C.L., H. Wang and D.I.C. Wang. (1977). Computer-aided material balancing for predicting biological parameters. Biotech. Bioeng. 19, 55-66.
9. Wang, H.Y., C.L. Cooney and D.I.C. Wang. (1977). Computer-aided baker's yeast fermentation. Biotech. Bioeng. 19, 67-86.
10. Wang, H.Y., D.I.C. Wang and C.L. Cooney. (1978). The application of dynamic calorimetry for monitoring growth for *Saccharomyces cerevisiae*. Eur. J. Appl. Microbiol. 5, 207-214.
11. Swartz, J.R. and C.L. Cooney. (1978). Instrumentation in computer-aided fermentation. Proc. Biochem. 13, 3-7.
12. Wang, H.Y., D.I.C. Wang and C.L. Cooney. (1978). Economic implication of computer control on yeast fermentation. ACS Meeting. Miami, FL.
13. Wang, H.Y., C.L. Cooney and D.I.C. Wang. (1979). Computer control of baker's yeast production. Biotech. Bioeng. 21, 975-995.
14. Swartz, J.R. and C.L. Cooney. (1979). Indirect fermentation measurements as a basis for control. Biotech. Bioeng. Symp. 9, 95-102.
15. Wang, H.Y., C.L. Cooney and D.I.C. Wang. (1979). On-line gas analysis for material balances and control. Biotech. Bioeng. Symp. 9, 13-24.
16. Cooney, C.L. (1979). Conversion yields in penicillin production. Proc. Biochem. 14(5) 31-33.
17. Weaver, J.C., C.R. Perley, F.M. Reames and C.L. Cooney. (1980). Temporarily immobilized microorganisms: rapid measurements using a mass spectrometer. Biotech. Letts. 2, 13-137.
18. Pungor, E., C.R. Perley, C.L. Cooney and J.C. Weaver. (1980). Continuous monitoring of fermentation outlet gas using computer coupled mass spectrometer. Biotech. Letts. 2, 409-414.
19. Weaver, J.C., C.R. Perley and C.L. Cooney. (1981). Mass spectrometer monitoring of a yeast fermentation. Enzy. Engr. 5, 85-88.
20. Gold, D., A. Mohagheghi, C.L. Cooney and D.I.C. Wang. (1981). Single-cell protein production from spent sulfite liquor utilizing cell recycle and computer monitoring. Biotech. Bioeng. 23, 2105-2116.

21. Pungor, E., J.C. Weaver and C.L. Cooney. (1981). Direct monitoring of fermentation in a computer-mass-spectrometer fermentor system. Advances in Biotechnology, Vol. 1, M. Moo-Young, ed., Pergammon Press, New York, pp. 393-399.
22. Cooney, C.L. (1981). Growth of microorganisms in biotechnology, in Microbial Fundamentals, Vol. 1, H.J. Rehmand and G. Reed, eds., Verlag-Chemie, Weinheim, W. Germany, pp. 95-112.
23. Pungor, E., A.M. Klibanov, C.L. Cooney and J.C. Weaver. (1982). Continuous DHO determination in H<sub>2</sub>O solution by a computer-mass spectrometer. Biomed. Mass Spectrom. 9, 181-185.
24. Cooney, C.L. and D.G. Mou. (1982). Applications of computer monitoring and control to the penicillin fermentation. Proceedings of the International Conference on Computer Aided Fermentation Technology.
25. DeTilly, G., D.G. Mou and C.L. Cooney. (1982). Optimization and economics of antibiotics production, in Filamentous Fungii, J.E. Smith, ed., Edward Arnold Publishers Ltd., London, pp. 190-209.
26. Pungor, E., Jr., C.L. Cooney and J.C. Weaver. (1982). Computer controlled mass spectrometer monitoring of fermentations. Enz. Eng. 6, 429-230.
27. Mou, D.G. and C.L. Cooney. (1983). Growth monitoring and control through computer-aided on-line mass balancing in a fed-batch penicillin fermentation. Biotech. Bioeng. 25, 226-255.
28. Mou, D.G. and C.L. Cooney. (1983). Growth monitoring and control in complex medium: a case study employing fed-batch penicillin fermentation and computer aided on-line mass balancing. Biotech. Bioeng. 25, 257-269.
29. Pungor E., Jr., E.J. Schaefer, C.L. Cooney and J.C. Weaver. (1983). Direct monitoring of the liquid and gas phases during a fermentation in a computer-mass-spectrometer-fermentor system. Eur. J. Microbiol. Technol. 18, 135-140
30. Cooney, C.L. (1983). Strategies for optimizing microbial growth and product formation, in Foundations in Biochemical Engineering, American Chemical Society Symposium Series, pp. 180-198.
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